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- (74) Agents: **STUMPF, Walter, L.** et al.; Chevron Corporation, Law Dept., P.O. Box 6006, San Ramon, CA 94583-0806 (US).
- (81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW.
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**WO 01/72933 A2**

(54) Title: OIL COMPOSITIONS HAVING IMPROVED FUEL ECONOMY EFFICIENCY

(57) Abstract: Lubricating oil compositions containing a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in an internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester are useful for improving the fuel economy of internal combustion engines.

1                                   **OIL COMPOSITIONS HAVING**  
2                                   **IMPROVED FUEL ECONOMY EFFICIENCY**

3  
4                                   **BACKGROUND OF THE INVENTION**

5  
6               With diminishing amounts of fossil fuel and rapidly increasing prices for this  
7 fuel, there has been a great deal of interest in reducing the amount of fuel consumed  
8 by automobile engines and the like. Thus, there is a need for lubricants that reduce  
9 the overall friction of the engine, thereby reducing the energy and fuel requirements  
10 of the engine.

11           Esters, and particularly glycerol esters, have been used as friction modifiers  
12 in motor oils. For example, U. S. Patent No. 4,495,088, issued January 22, 1985 to  
13 Liston, discloses lubricating oils containing borated fatty acid esters of glycerol and  
14 a succinimide. The fatty acid monoester of glycerol is said to be preferred, though  
15 mixtures of mono- and diesters may be used. These mixtures contain at least 40% of  
16 the monoester. Preferably, the mixtures of mono- and diesters contain from 40 to  
17 60 percent by weight of the monoesters. It is stated that commercial glycerol  
18 monooleate contains a mixture of from 45 % to 55% by weight monoester and from  
19 55% to 45 % diester.

20           U. S. Patent No. 4,683,069, issued July 28, 1987 to Brewster et al., discloses  
21 lubricating oil compositions which contain 0.05 to 0.2 wt. % of a glycerol partial  
22 ester of a C<sub>16</sub>-C<sub>18</sub> fatty acid as a fuel economy additive. Optimum efficiency is said  
23 to be found at about the 0.2 weight percent level and use in excess of this amount is  
24 said to be possibly detrimental to the overall performance of the lubricating oil  
25 composition. In the examples, a mixture of glycerol monooleate (GMO) and  
26 glycerol dioleate (GDO) in a weight ratio of 3 parts GMO to 2 parts GDO is used in  
27 a lubricating oil. For comparative purposes, Example 2 uses this  
28 GMO/GDO mixture at levels of 0.3, 0.5, 0.4 and 0.9 wt. %.

29           European Patent No. 0092946, published November 2, 1983 discloses  
30 lubricating oil compositions containing 0.2 wt. % GMO, or a mixture of GMO and

1 GDO in a weight ratio of 3 parts GMO to 2 parts GDO. For comparative purposes,  
2 Example 2 uses this GMO/GDO mixture at levels of 0.3, 0.5, 0.4 and 0.9 wt. %.

3 European Patent No. 0466297, published January 15, 1992, discloses the use  
4 of mono-, di- or triesters of glycerol in lubricating oils to improve compatibility with  
5 nitrile rubbers. The ester can be used in an amount from 0.01 to 3.0 weight percent  
6 based on the weight of the oil composition.

7 It has now been found that lubricating the crankcase of an internal  
8 combustion engine with a lubricating oil containing 0.3 to 0.6 weight percent of a  
9 monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and  
10 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a  
11 carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at  
12 least 75 mole percent of the mixture is monoester reduces the fuel consumption of  
13 the engine.

14

#### 15 SUMMARY OF THE INVENTION

16

17 In accordance with the present invention, there is provided a lubricating oil  
18 composition comprising a major amount of an oil of lubricating viscosity and, in an  
19 amount effective to reduce fuel consumption in an internal combustion engine, a  
20 monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and  
21 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a  
22 carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at  
23 least 75 mole percent of the mixture is monoester.

24 Also provided in accordance with this invention is a method for reducing the  
25 fuel consumption of an internal combustion engine comprising treating the moving  
26 surfaces thereof with a lubricating oil composition comprising a major amount of an  
27 oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in  
28 the internal combustion engine, a monoester of glycerol and a carboxylic acid  
29 containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a  
30 monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon

1 atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is  
2 monoester.

3

4

#### DETAILED DESCRIPTION OF THE INVENTION

5

6 Typically, glycerol esters of fatty acids, such as oleic acid, are prepared by  
7 reacting glycerol and a fatty acid. The product of this reaction is often referred to as,  
8 e.g., glyceryl monooleate. However, in a typical commercial product, only about  
9 50-60 mole percent of the esters produced are monoesters. The remainder are  
10 primarily diesters, with a small amount of triester. Furthermore, while the product is  
11 referred to as glyceryl monooleate (because the starting acid was oleic acid), a  
12 typical commercial product contains esters of acids other than oleic acid, because the  
13 "oleic acid" used to prepare the ester is, in fact, a mixture of acids of which oleic  
14 acid may constitute only about 70 mole percent of the acids. Thus, a typical  
15 commercial "glyceryl monooleate" may actually contain only about 38-40 mole  
16 percent glyceryl monooleate.

17 Canadian Patent No. 1,137,463, issued December 14, 1982, and  
18 Canadian Patent No. 1,157,846, issued November 29, 1983 confirm this usage of the  
19 term "glyceryl monooleate" when referring to a mixture of mono-, di, and/or  
20 triesters. Both patents state that "When glycerol is esterified with a fatty acid,  
21 mono-, di- and triesters form. Commercial glycerol monooleate, for example,  
22 contains a large amount of dioleate and a minor proportion of trioleate.  
23 Mono-, di- and tri-esters thereof are contemplated for use in this invention. When,  
24 for the sake of convenience, the common term such as 'glycerol monooleate' is used,  
25 the di- and trioleates are to be included within the meaning of glycerol monooleate."

26 The esters of the present invention are also prepared by reacting glycerol and  
27 a C<sub>12</sub>-C<sub>20</sub> carboxylic acid containing 0 to 3 double bonds in a conventional manner  
28 well known in the art. The preferred acid is oleic acid. As with the commercial  
29 products described above, the resulting product is a mixture of mono-, di- and  
30 triesters. However, this reaction mixture is then distilled using conventional

1 techniques, and the monoester portion of the distillate is recovered. This can result  
2 in a product which is essentially all monoester. Thus, the esters used in the  
3 lubricating oil compositions of this invention may be all monoesters, or a mixture of  
4 mono- and diesters in which at least 75 mole percent, preferably at least 90 mole  
5 percent, of the mixture is the monoester.

6 The monoester or mixture of mono- and diesters is used in an amount  
7 effective to reduce fuel consumption in an internal combustion engine. Typically,  
8 the lubricating compositions of this invention contain at least 0.3, preferably 0.3 to  
9 2.0 weight percent of the monoester or mixture of mono- and diesters.

10 The esters of this invention may also be borated. Boration passivates  
11 hydroxyl groups on the glycerol portion of the esters which helps improve  
12 compatibility with rubber seals. If the borated product is desired, it can be prepared  
13 by borating the ester with boric acid with removal of the water of reaction.  
14 Preferably, there is sufficient boron present such that each boron will react with from  
15 1.5 to 2.5 hydroxyl groups present in the reaction mixture. The reaction may be  
16 carried out at a temperature in the range of 60°C. to 135°C., in the absence or  
17 presence of any suitable organic solvent such as methanol, benzene, xylenes,  
18 toluene, neutral oil and the like. A method for borating esters is disclosed in  
19 U. S. Patent No. 4,495,088, issued January 22, 1985 to Liston, which is incorporated  
20 by reference.

21 The lubricating oil used in the compositions of this invention may be mineral  
22 or synthetic oils of viscosity suitable for use in the crankcase of an internal  
23 combustion engine. Crankcase lubricating oils ordinarily have a viscosity of about  
24 1300 cSt at 0°F. to 22.7 cSt at 210°F. (99°C.). The lubricating oils may be derived  
25 from synthetic or natural sources. Mineral oils useful in this invention include  
26 paraffinic, naphthenic and other oils used in lubricating oil compositions. Synthetic  
27 oils include both hydrocarbon synthetic oils and synthetic esters. Useful synthetic  
28 hydrocarbon oils include liquid polymers of alpha olefins having the proper  
29 viscosity. Useful synthetic esters include the esters of both monocarboxylic and  
30 polycarboxylic acids as well as monohydroxy alkanols and polyols.

1           It has been found that the effect of the esters of this invention on lubricating  
2 oil compositions is most pronounced in oils that have a relatively low viscosity.  
3 Therefore, the preferred oils for use in the lubricating oil compositions of this  
4 invention are those with viscosity in the range of 6 to 13 cSt kinematic viscosity at  
5 100 °C. and of 2000 cP at -30°C. to 3500 cP at -20°C. low temperature cranking  
6 viscosity as defined in Society of Automotive Engineering Specification J300..

7           The lubricating oil compositions of this invention may also contain  
8 additives other than the esters of this invention. These other additives can  
9 comprise ashless dispersants which are typically nitrogen-containing  
10 dispersant additives that are oil soluble salts, amides, imides and esters made  
11 from high molecular weight mono- and dicarboxylic acids and various amines  
12 having an amino or heterocyclic nitrogen with at least one amido or hydroxy group  
13 capable of salt, amido, or ester formation. Preferred are the reaction products of  
14 polyolefin (C<sub>2</sub>-C<sub>5</sub> olefin), such as polyisobutenyl, succinic anhydride with an  
15 alkylene polyamine such as tetraethylenepentamine. Such dispersants are disclosed  
16 in U. S. Patent No. 4,683,069, issued July 28, 1987 to Brewster et al., which is  
17 incorporated by reference. Dispersants are used generally in amounts from about  
18 0.1 to 10 wt. %, preferably in the range of about 0.5 to 5 wt. % based on the weight  
19 of the lubricating oil composition.

20           Detergents may also be used in the lubricating oils compositions of this  
21 invention. They include the neutral, basic or overbased metal (normally alkali or  
22 alkaline earth metal) salts of petroleum naphthenic acids, petroleum sulfonic acids,  
23 alkylaryl sulfonic acids, alkyl phenols, alkylene-bis-phenol, oil soluble fatty acids  
24 and the like. The preferred materials are the neutral or overbased calcium or  
25 magnesium phenates, sulfurized phenates and/or sulfonates. These detergents are  
26 typically used in amounts from 1 to 3 wt. % based on the total weight of the  
27 lubricating oil composition.

28           Oxidation inhibitors may also be used. Examples of oxidation inhibitors  
29 include hindered phenols, such as 2,6-ditertiary butyl para-cresol, amines, sulfurized

1 phenol and alkyl phenothiazines. Normally, they are used in amounts from about  
2 0.01 to 3 wt. % based on the weight of the lubricating oil composition.

3 The lubricating oil compositions can also contain pour point depressants,  
4 which are usually present in amounts from about 0.01 to 1 wt. % based on the  
5 weight of the lubricating oil composition. They include wax alkylated aromatic  
6 hydrocarbons, olefin polymers and copolymers, and acrylate and methacrylate  
7 polymers and copolymers.

8 Anti-wear additives may also be used. Typically they are oil soluble zinc  
9 dihydrocarbyldithiophosphates having at least a total of 5 carbon atoms, the alkyl  
10 group preferably being C<sub>2</sub>-C<sub>8</sub>. They are typically present in amounts of from 0.01 to  
11 5 wt. %, preferably 0.5 to 1.5 wt. %, based on the weight of the lubricating oil  
12 composition.

13 Viscosity index improvers, or viscosity modifiers may also be included in the  
14 lubricating oil compositions of this invention. Normally, they are olefin polymers  
15 such as polybutene, ethylene-propylene copolymers, hydrogenated polymers and  
16 copolymers and terpolymers of styrene with isoprene and/or butadiene, polymers of  
17 alkyl acrylates and alkyl methacrylates, copolymers of alkyl methacrylates with  
18 N-vinyl pyrrolidone or dimethylaminoalkyl methacrylate, post-grafted polymers of  
19 ethylene-propylene with an active monomer such as maleic anhydride which may be  
20 further reacted with an alcohol, or an alkylene polyamine, styrene-maleic anhydride  
21 polymers post-treated with alcohols and amines and the like. These additives are  
22 used in amounts of about 1.5 to 15 wt. % based on the weight of the lubricating oil  
23 composition, depending on the exact viscosity specification desired.

24 The foregoing additives (other than the esters of this invention) are used in  
25 amounts normally necessary to provide their attendant functions in a fully  
26 formulated crankcase lubricating oil composition. Very small proportions of  
27 additional special purpose additives, such as anti-foam agents or rust inhibitors may  
28 also be present in the lubricating oil compositions of this invention.

This invention will be further understood by reference to the following illustrative examples. The examples include preferred but non-limiting embodiments of the invention.

#### EXAMPLES 1-6

Lubricating oil compositions were formulated using the components indicated in the table below.

Baseline formulation	5W30
PIBSAPAM dispersant	4 wt. %
Ca sulfonate - low overbased detergent	6 mmoles
Ca phenate - high overbased detergent	55 mmoles
Zinc dialkyldithiophosphate - antiwear	15 mmoles
Molybdenum antioxidant	0.15 wt. %
Antifoam	5 ppm
Pour point depressant	0.2 wt. %
Ethylene-propylene copolymer - viscosity index improver	9.5 wt. %
Base oil	100

The method for evaluating fuel economy performance of the formulations below is similar to ASTM Research Report RR-D2-1364. It used a 4.6 L V-8 Ford engine operating under three operating conditions. The sample test oil was tested for three hours under each operating condition. Fuel consumption was measured during operation. Before and after each sample test, a base case oil was tested under the same operating conditions. Fuel economy is indicated below as the weighted percent improvement of the sample oil relative to the base case. Percent fuel economy improvement is calculated using the following formula:

$$\% \text{ Fuel Economy Improvement} = (\text{FCBC} - \text{FCSample}) / \text{FCBC} \times 100 \times \text{Weighting Factors}$$



1 where FCBC is the fuel consumption for the base case and FC<sub>Sample</sub> is the fuel  
2 consumption for a given sample. Weighting factors are derived from ASTM  
3 methods of fuel economy determination.

4 The table below indicates the percent fuel economy improvement for the  
5 following six samples:

6  
7 Sample A - Base case oil

8 Sample B - Base case oil with 0.3 wt. % of a mixture of 68 mole % borated glycerol  
9 monooleate (GMO) and 32 mole % borated glycerol dioleate (GDO)

10 Sample C - Base case oil with 0.3 wt. % of a mixture of 68 mole % non-borated  
11 GMO and 32 mole % non-borated GDO

12 Sample 1 - Base case oil with 0.3 wt. % of a mixture of 94 mole percent borated  
13 GMO and 6 mole percent borated GDO

14 Sample 2 - Same as Sample 1

15 Sample 3 - Base case oil with 0.3 wt. % of a mixture of 94 mole percent non-borated  
16 GMO and 6 mole percent non-borated GDO

17

Sample	% Fuel Economy Improvement
A	-92.05
B	-7.54
C	12.19
1	21.15
2	25.63
3	32.45

18

19

20

## 1 WHAT IS CLAIMED IS:

2

3 1. A lubricating oil composition comprising a major amount of an oil of  
4 lubricating viscosity and, in an amount effective to reduce fuel consumption in  
5 an internal combustion engine, a monoester of glycerol and a carboxylic acid  
6 containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a  
7 monoester and a diester of glycerol and a carboxylic acid containing 12 to  
8 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of  
9 the mixture is monoester.

10

11 2. The composition of claim 1 wherein the amount of monoester or mixture of  
12 monoester and diester is at least 0.3 weight percent.

13

14 3. The composition of claim 1 wherein the amount of monoester or mixture of  
15 monoester and diester is 0.3 to 2.0 weight percent.

16

17 4. The composition of claim 1 wherein at least 90 mole percent of the mixture of  
18 monoester and diester is monoester.

19

20 5. The composition of claim 1 wherein the carboxylic acid containing 12 to  
21 20 carbon atoms and 0 to 3 double bonds is oleic acid.

22

23 6. The composition of claim 1 wherein the ester is borated.

24

25 7. A method for reducing the fuel consumption of an internal combustion engine  
26 comprising treating the moving surfaces thereof with a composition  
27 comprising a major amount of an oil of lubricating viscosity and, in an amount  
28 effective to reduce fuel consumption in the internal combustion engine, a  
29 monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms  
30 and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol

- 1           and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double  
2           bonds wherein at least 75 mole percent of the mixture is monoester.  
3
- 4    8.    The method of claim 7 wherein the amount of monoester or mixture of  
5           monoester and diester is at least 0.3 weight percent.  
6
- 7    9.    The method of claim 7 wherein the amount of monoester or mixture of  
8           monoester and diester is 0.3 to 2.0 weight percent.  
9
- 10  10.   The method of claim 7 wherein at least 90 mole percent of the mixture of  
11          monoester and diester is monoester.  
12
- 13  11.   The method of claim 7 wherein the carboxylic acid containing 12 to 20 carbon  
14          atoms and 0 to 3 double bonds is oleic acid.  
15
- 16  12.   The method of claim 7 wherein the ester is borated.  
17  
18

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- (84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).
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- (72) Inventor: BOFFA, Alexander, B.; 6088 Arlington Boulevard, Richmond, CA 94805 (US).
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WO 01/72933 A3

(54) Title: OIL COMPOSITIONS HAVING IMPROVED FUEL ECONOMY EFFICIENCY

(57) Abstract: Lubricating oil compositions containing a major amount of an oil of lubricating viscosity and, in an amount effective to reduce fuel consumption in an internal combustion engine, a monoester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds, or a mixture of a monoester and a diester of glycerol and a carboxylic acid containing 12 to 20 carbon atoms and 0 to 3 double bonds wherein at least 75 mole percent of the mixture is monoester are useful for improving the fuel economy of internal combustion engines.

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 01/09566

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C10M129/76 C10M139/00 //(C10M129/76,129:76),C10N30:06,  
C10N40:25,C10N60:14

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C10M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 683 069 A (BREWSTER PHILLIP W ET AL) 28 July 1987 (1987-07-28) cited in the application column 2, line 21 - line 40; example 1; table I ---	1,5,7,11
X A	EP 0 036 708 A (MOBIL OIL CORP) 30 September 1981 (1981-09-30) page 6; table 1 page 3, paragraph 3 -page 4, paragraph 1 ---	1-3,5-9, 11,12 4,10
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A	US 5 114 603 A (KENNEDY STEVEN ET AL) 19 May 1992 (1992-05-19) column 2, line 6 - line 63; examples 1-3 --- -/--	1-5,7-11



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

### \* Special categories of cited documents:

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Date of the actual completion of the international search

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Name and mailing address of the ISA

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Authorized officer

Rotsaert, L

# INTERNATIONAL SEARCH REPORT

International Application No

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 038 355 A (CHEVRON RES) 23 July 1980 (1980-07-23) the whole document ---	1-5,7-11
A	US 4 495 088 A (LISTON THOMAS V) 22 January 1985 (1985-01-22) cited in the application column 1, line 5 - line 42 column 3, line 10 - line 18 -----	1-12

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 01/09566

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